

# Iron isotopic compositions in shelf, slope and basin sediments from the Arctic Ocean

## Introduction

- The continental margin in the Arctic Ocean (AO) comprises about 50% of the total ocean area. The AO is therefore an exceptional laboratory to investigate shelf-basin interactions and their impacts on biogeochemical cycles.
- Here, we have determined the profiles of the concentrations and isotopic compositions of total Fe, reactive Fe and pyrite-Fe in sediment cores collected in AO shelf, slope and basin.
- Our objective is to improve understanding of the early diagenesis influence on the AO Fe cycle.

## Sampling sites

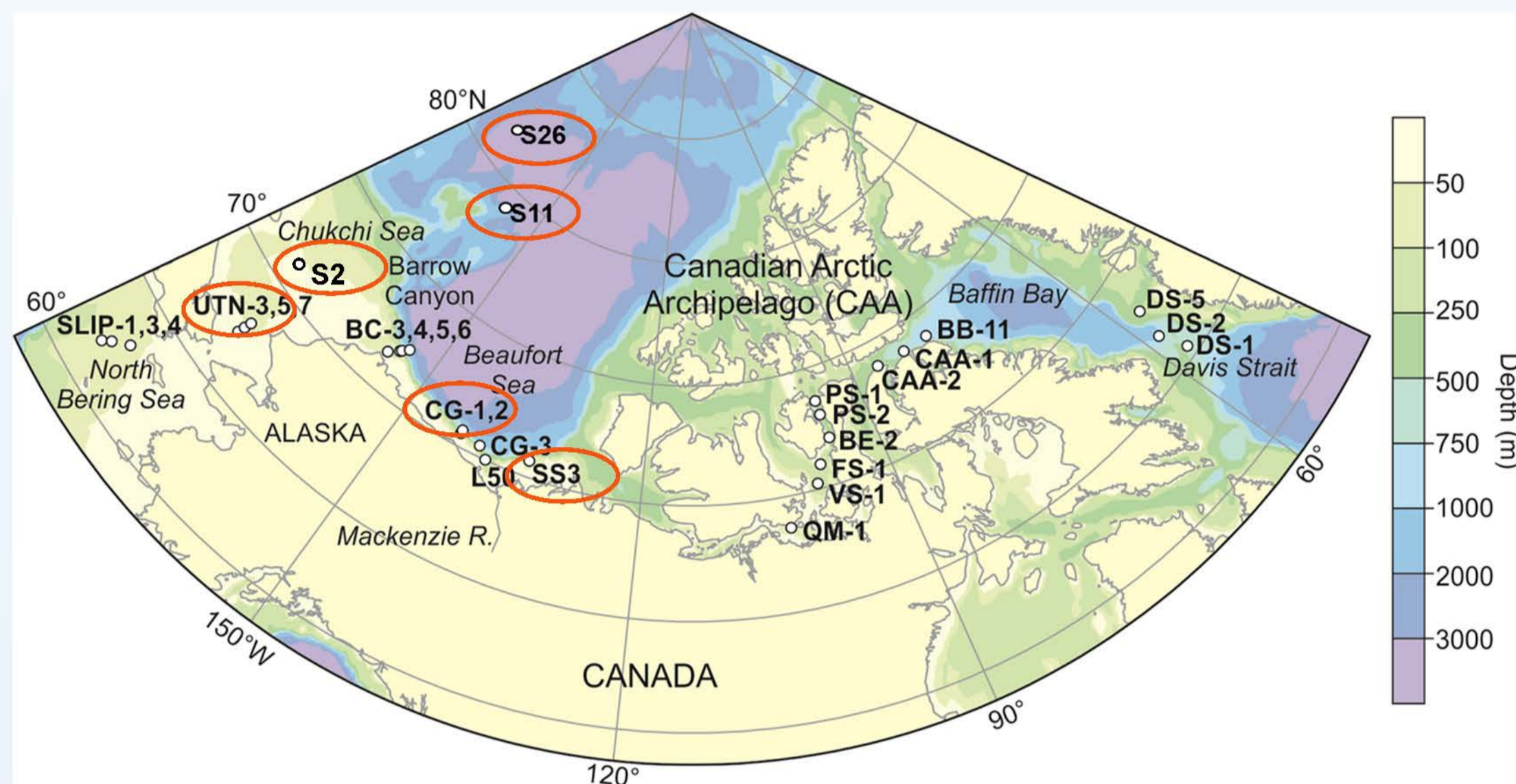


Figure 1. Seven sediment box-cores from the AO were analyzed for this study (see red arrows). Cores UTN5, S2 and CG1 were collected on the shelf at water depths of 51, 52 and 204 m, respectively, cores SS3 and CG2 on the slope at depths of 274 and 619 m, respectively, and cores S11 and S26 from the AO interior at depths of 2265 m and 3130 m, respectively.

## Results

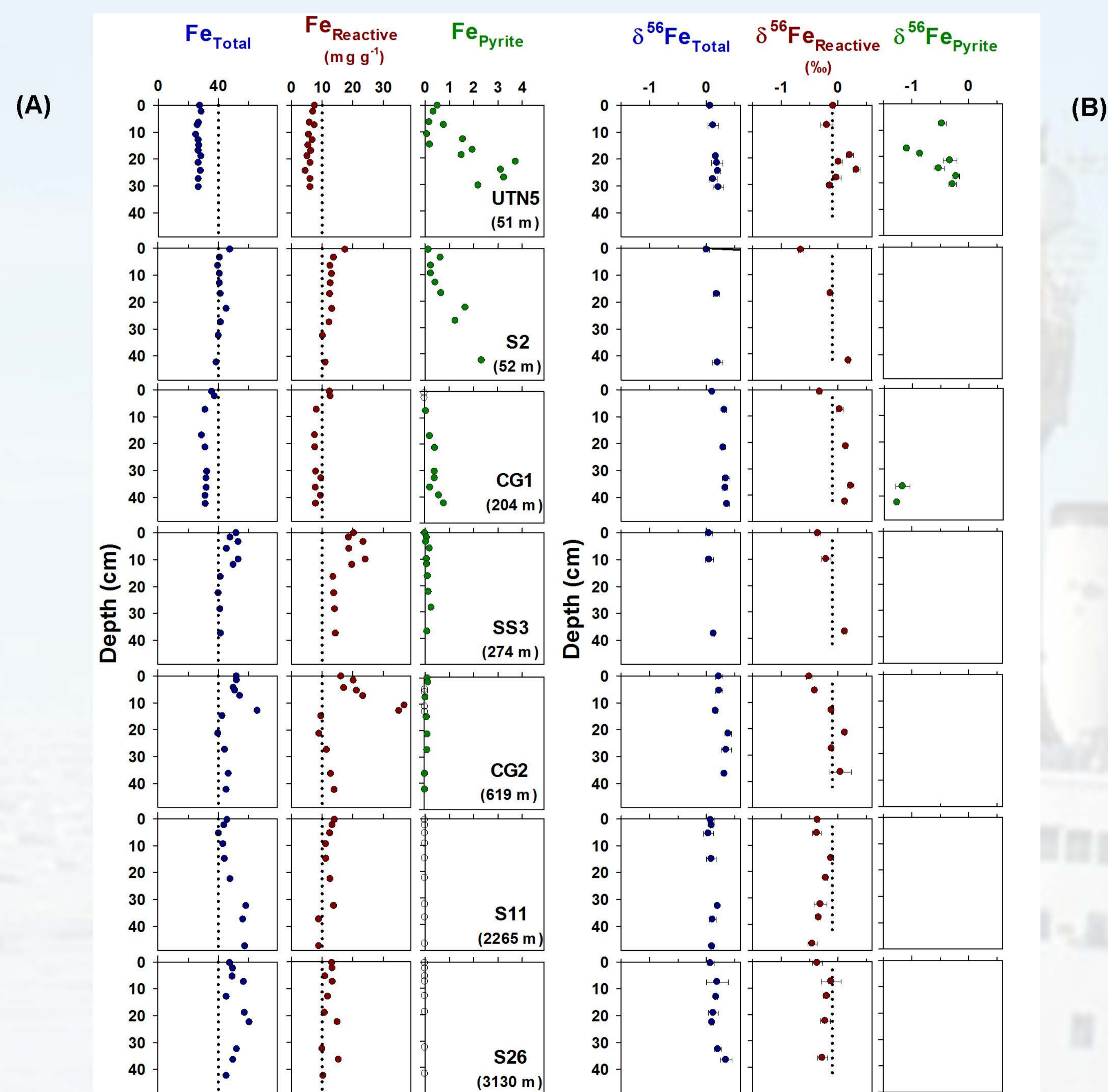


Figure 2A. Vertical profiles of total Fe ( $Fe_{Total}$ ), reactive Fe ( $Fe_{Reactive}$ ) and pyrite Fe ( $Fe_{Pyrite}$ ) concentrations in the sediments.  $Fe_{Total}$  was obtained after a complete digestion of the sediment with a mixture of  $HNO_3$ ,  $HClO_4$  and HF.  $Fe_{Reactive}$  was extracted from the sediments with a 1 M HCl solution during 24 h. This operationally defined Fe fraction is believed to include Fe oxihydroxides and Fe monosulfide.  $Fe_{Pyrite}$  was also determined by an operationally defined extraction method (Lord, 1982). Empty dots are values below detection limit ( $\sim 0.1$  mg g<sup>-1</sup> for  $Fe_{Pyrite}$ ).

Figure 2B. Vertical profiles of  $\delta^{56}Fe_{Total}$ ,  $\delta^{56}Fe_{Reactive}$  and  $\delta^{56}Fe_{Pyrite}$  in the sediments, where  $\delta^{56}Fe = [(^{56}Fe/^{54}Fe)_{sample} / (^{56}Fe/^{54}Fe)_{JRM-14} - 1] \times 10^3$ . Measurements were achieved with an MC-ICP-MS following purification through a standard anion exchange protocol. The average reproducibility of the measurements, determined by triplicate analyses of each sample, was  $\pm 0.06\%$ . Measurements of the  $\delta^{56}Fe$  in the reference material BHVO-2 ( $0.14 \pm 0.05\%$ ) was in good agreement with the value ( $0.114 \pm 0.011\%$ ) reported by Craddock and Dauphas (2010).

### Key points:

- The concentrations and inventories of  $Fe_{Total}$  and  $Fe_{Reactive}$  are higher in slope and basin sediments than in shelf sediments.
- The profiles of  $\delta^{56}Fe_{Total}$  and  $\delta^{56}Fe_{Reactive}$  exhibit values that are slightly lower in surface sediments ( $\sim 0-5$  cm) than in sediments from the bottom of the cores.
- $Fe_{Pyrite}$  is only present in shelf cores (UTN5, S2 and CG1) where it increases with sediment depth and is characterized by  $\delta^{56}Fe$  values significantly lower than those of  $Fe_{Reactive}$ .

## Results

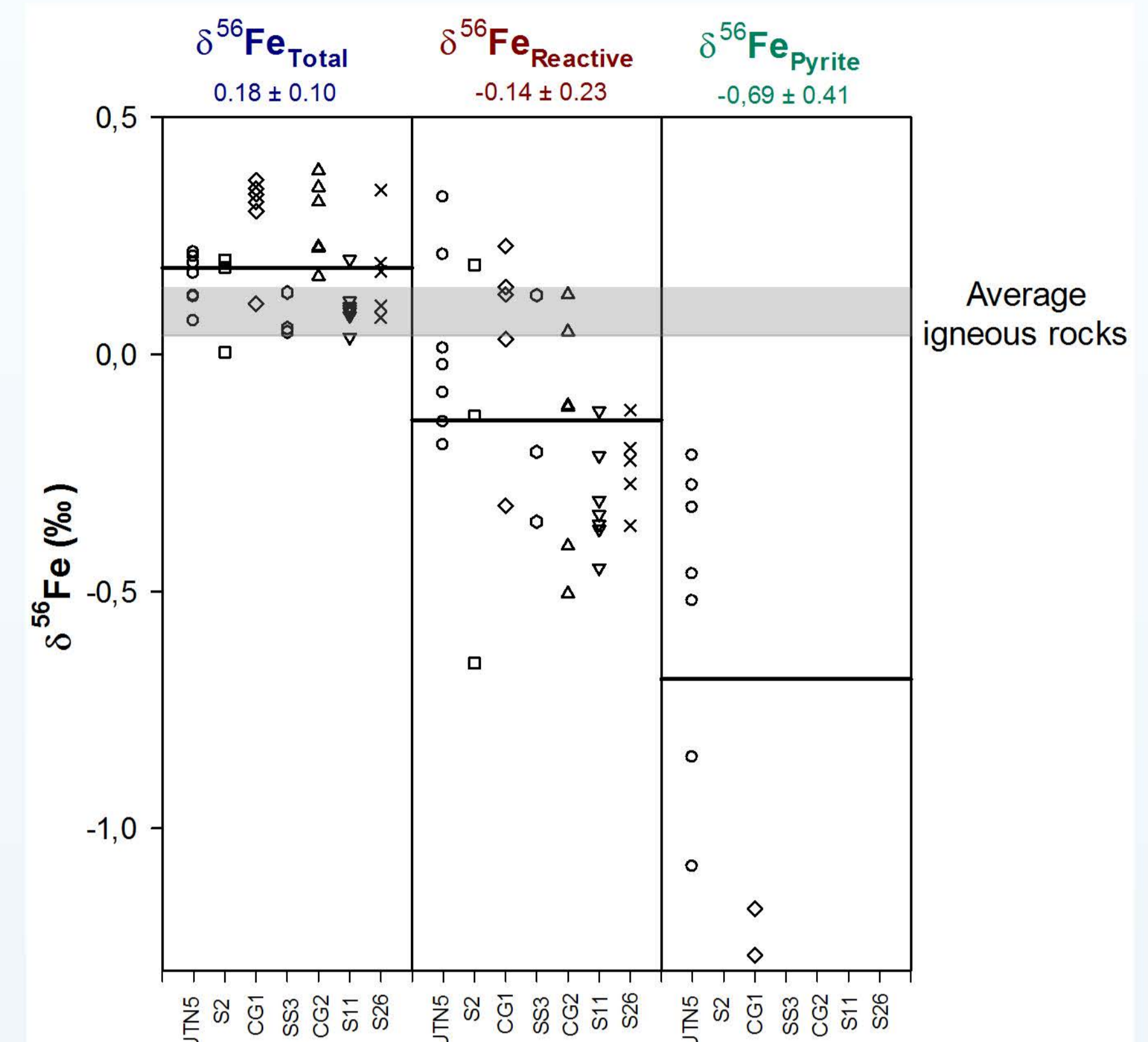


Figure 3. Graphic illustrating differences between  $\delta^{56}Fe_{Total}$ ,  $\delta^{56}Fe_{Reactive}$  and  $\delta^{56}Fe_{Pyrite}$ . The gray area corresponds to the average value of  $\delta^{56}Fe$  for igneous rocks ( $0.09 \pm 0.05\%$ ) (Beard et al., 2003).

### Key points:

- $Fe_{Reactive}$  is enriched in light isotopes ( $\delta^{56}Fe_{Reactive} = -0.14 \pm 0.23\%$ ) compared to  $Fe_{Total}$  ( $\delta^{56}Fe_{Total} = +0.18 \pm 0.10\%$ ), but depleted in light isotopes relative to  $Fe_{Pyrite}$  ( $\delta^{56}Fe_{Pyrite} = -0.69 \pm 0.41\%$ ).
- $\delta^{56}Fe_{Total}$  values ( $0.18 \pm 0.10\%$ ) are in the range of those measured in other continental margin sediments (Scholz et al., 2014) (Severmann et al., 2006).
- $\delta^{56}Fe_{Pyrite}$  ( $-0.69 \pm 0.41\%$ ) values are also similar to those found in other continental margin sediments ( $-0.71 \pm 0.2\%$ ) (Severmann et al., 2006).

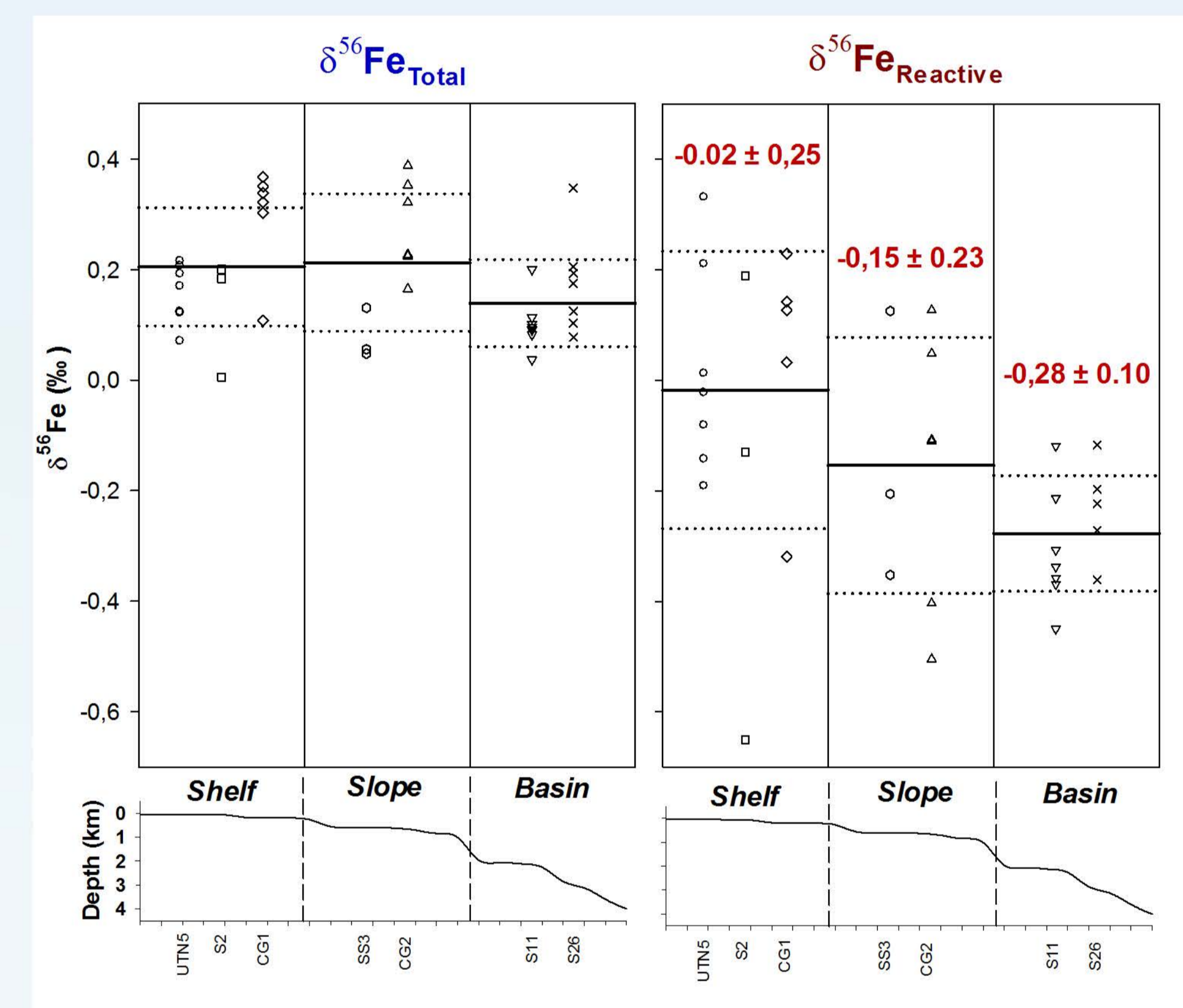


Figure 4. Spatial variations of  $\delta^{56}Fe_{Total}$  and  $\delta^{56}Fe_{Reactive}$  between shelf, slope and basin sediments

### Key points

- Values of  $\delta^{56}Fe_{Total}$  do not differ much among shelf and slope sediments but are slightly lower in basin sediments.
- The mean value of  $\delta^{56}Fe_{Reactive}$  are significantly lower (enriched in  $^{54}Fe$ ) in basin sediments ( $-0.28\%$ ) relative to shelf sediments ( $-0.02\%$ ).

## Preliminary conclusions

- Early diagenetic processes produced Fe authigenic phases (oxihydroxides, pyrites) that are enriched in  $^{54}Fe$ .
- Elevated concentrations of  $Fe_{Reactive}$  in basin sediments and its light isotopic composition compared to shelf sediments is compatible with the notion that Fe recycled through early diagenesis in shelf sediments may migrate and be deposited in basin sediments.
- Stable Fe isotopes are a promising tool to better document large-scale pathways affecting the distribution of Fe in the AO.

## Acknowledgment

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## References:

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